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Digital Radiography of NIF RadHohl 09A Ta2O5 Target 54

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Disclaimer

This work performed under the auspices of the U.S. Department of Energy by Lawrence Livermore National Laboratory under Contract DE-AC52-07NA27344.

Digital radiography of NIF RadHohl 09A Ta_2O_5 Target 54 (Rev. 3)

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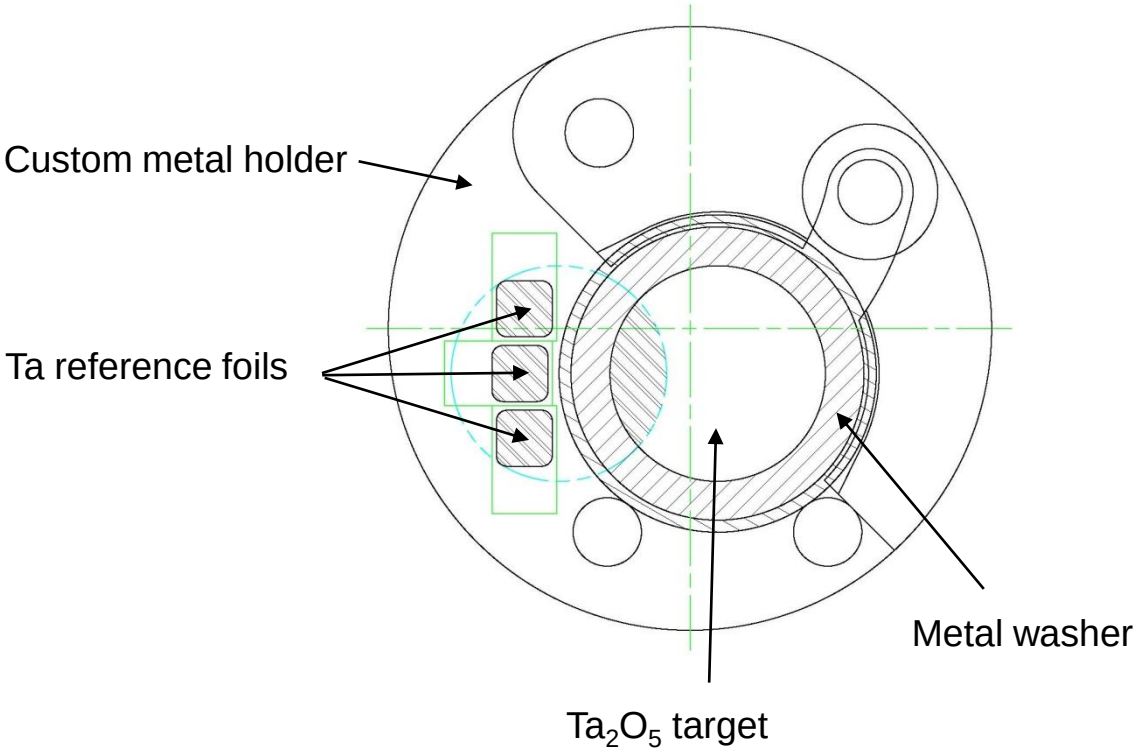
Background information for the digital radiography data collection and analysis

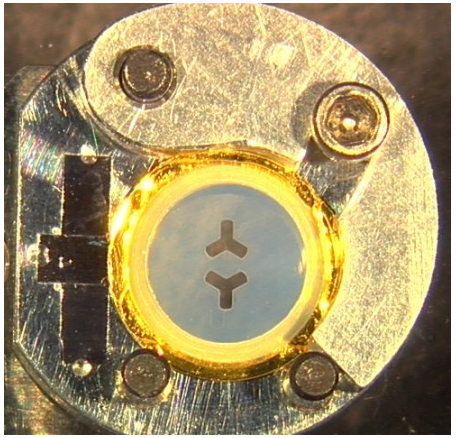
- Digital radiography data was collected for NIF RadHohl-09A Target 54 (MMED #54, NDE #T54). Three data sets were collected in order to:
  - characterize the relative density uniformity of the tantalum-oxide (Ta_2O_5) target material,
  - note readily-observable non-uniform features in the target, and
  - estimate the density of the target material.

- The Xradia Micro XCT system in B432 was used to collect the data. The system parameters were:
  - source:
    - x-ray energy = 49 kVp
    - power and current = 3.3 W and 66 µA
  - detector:
    - imaging optics magnifications = 4X, 20X
    - effective pixel widths = 3.0 µm (4X), 0.6 µm (20X)
    - integration time = 250 secs (5 frame-averaged 50-second integrations)

- The data collection and analysis follow the procedure set forth in the document titled “Xradia Micro XCT Radiographic Metrology of Radiation Transport Ta_2O_5 Foam Targets (Rev. 5)”.

The target was mounted on a metal washer and placed in a custom holder for the radiography.

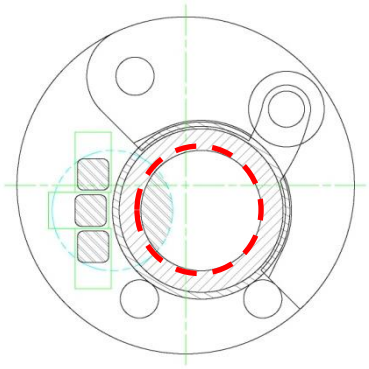




Photograph by Rick Vargas (TRED)

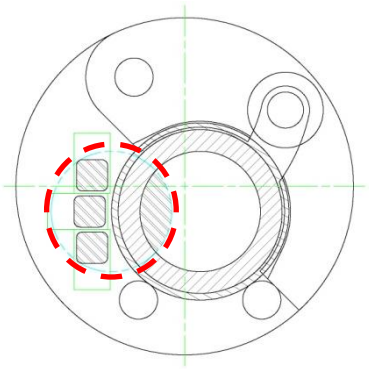
NOTE: This is only a representative picture of how a target is mounted. The target pictured is not the one characterized in this report.

Data sets were collected for the following three imaging configurations.



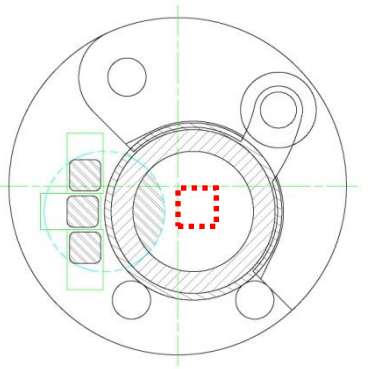
Focus: complete target

System magnification: 4X



Focus: part of target with 3 reference foils

System magnification: 4X



Focus: region of target with no significant features

System magnification: 20X

The region of interest in each configuration is indicated by the red dashed line.

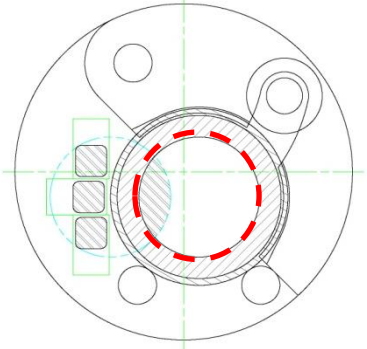
The first data set captured an image of the whole target.

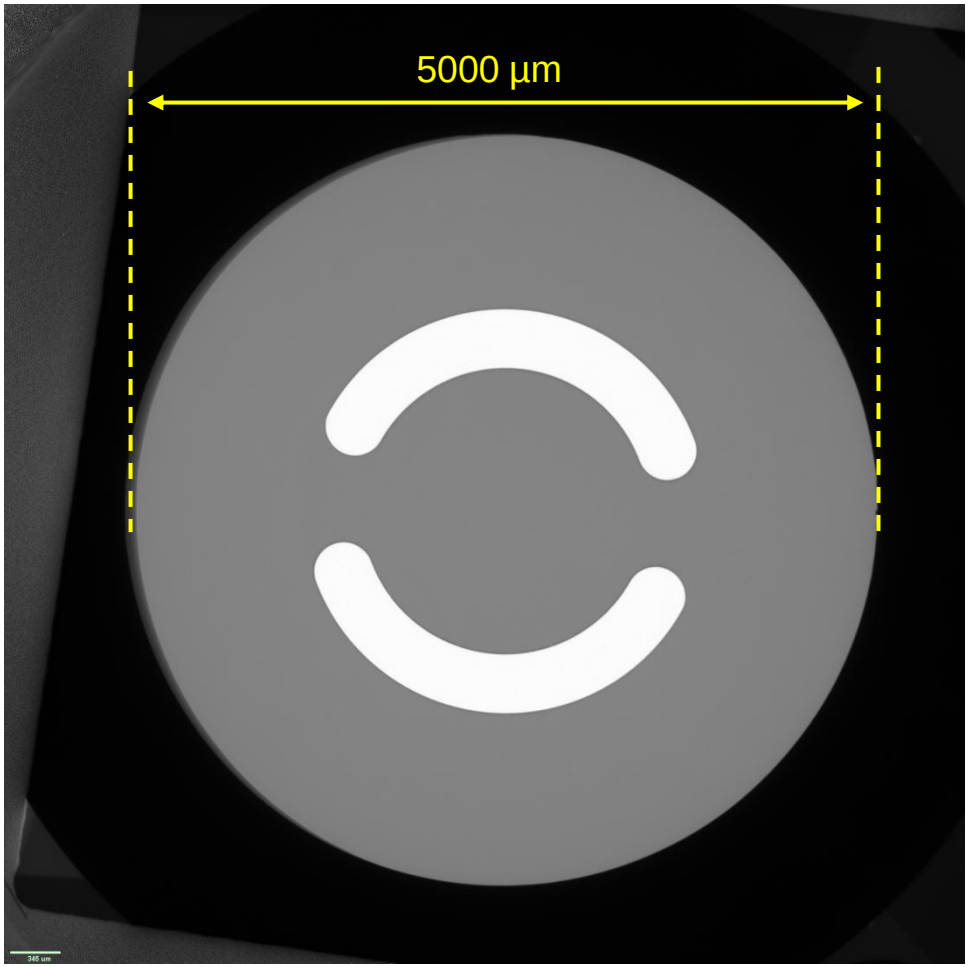
System magnification: 4X

Pixel value dynamic range: full

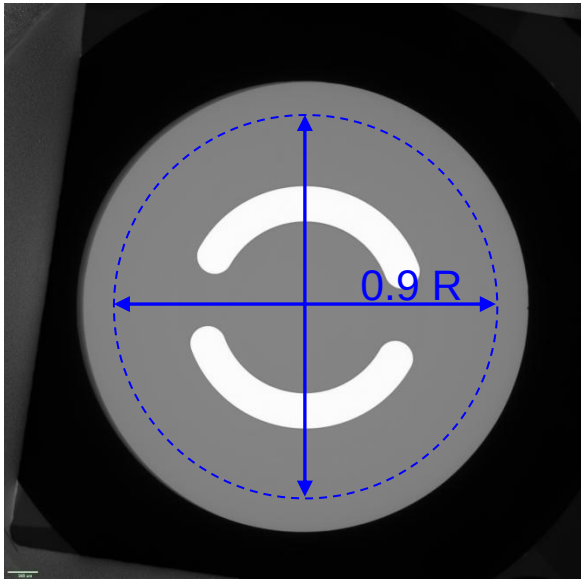
Target type: 2S-2W

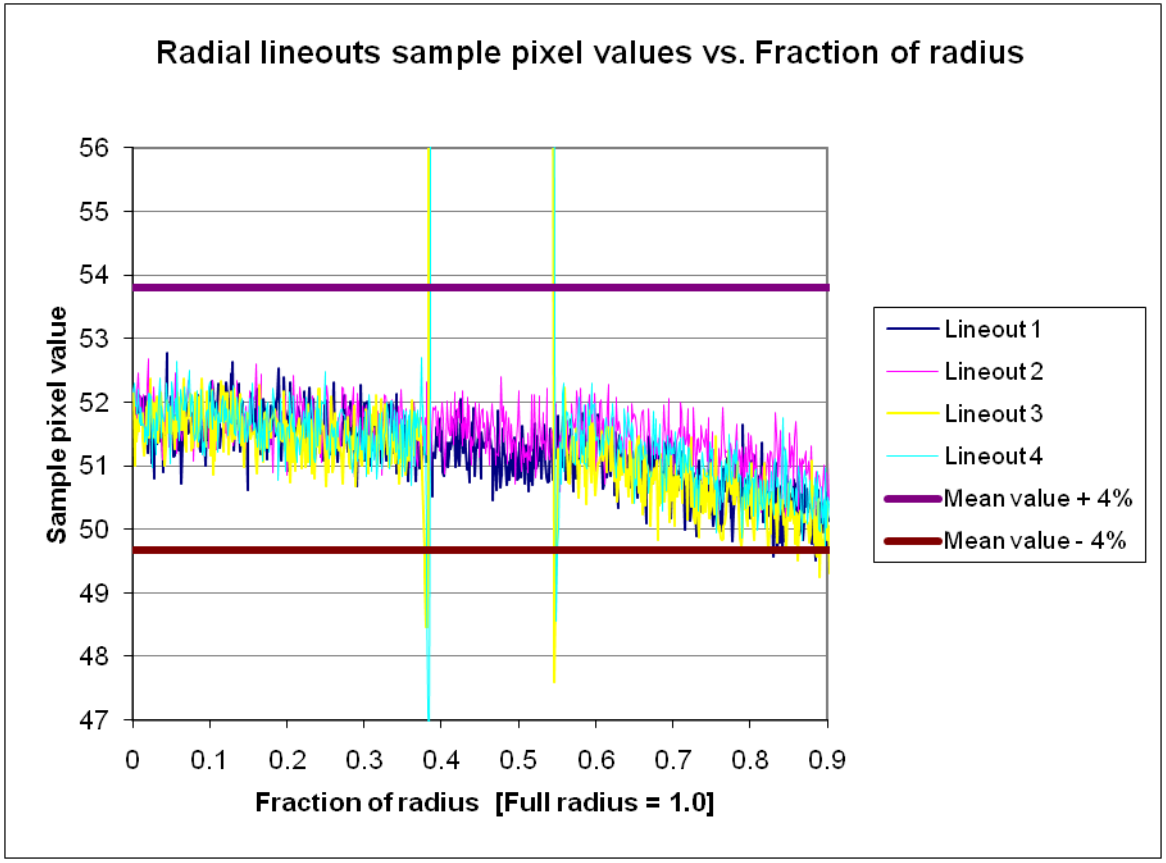
Region of interest





Several sample radial lineouts indicate that the target met the specifications for thickness uniformity.





Specification: The sample thickness and/or density of the target, within a region bounded by a circle representing 90% of the full radius of the target, shall not deviate more than 4% from the mean sample thickness and/or density as calculated at the center of the target.

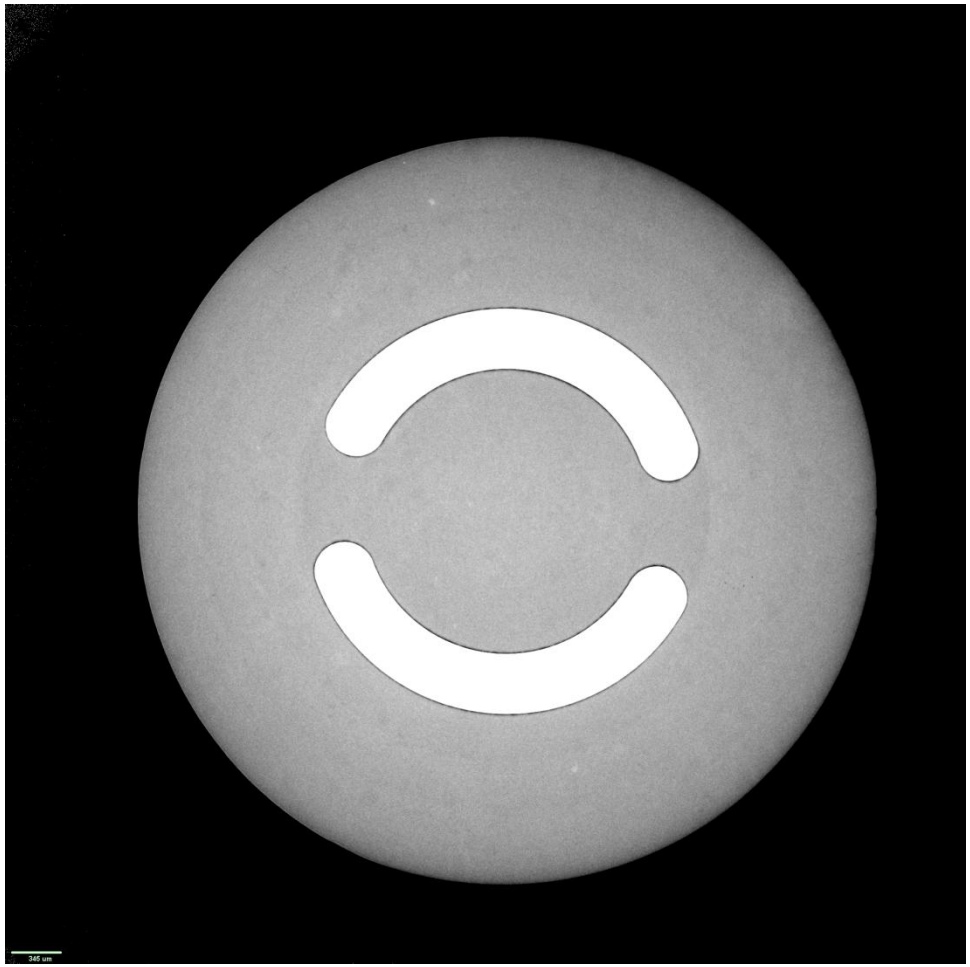
Note: Given that (1) density and thickness variations cannot necessarily be decoupled in an x-ray projection image and (2) the x-ray source is non-monoenergetic, the final determination as to whether the target meets the stated specification requires further calculations by project personnel.

Restriction of the pixel value dynamic range allows for observation of non-uniformities.

System magnification: 4X

Pixel value dynamic range: restricted

Target type: 2S-2W



Observed non-uniformities

Artifacts intrinsic to imaging system:

1. n/a

Features in target:

2. n/a

The second data set captured an image of the three reference foils and part of the target.

System magnification: 4X

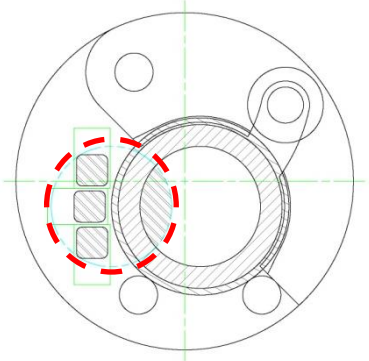
Pixel value dynamic range: full

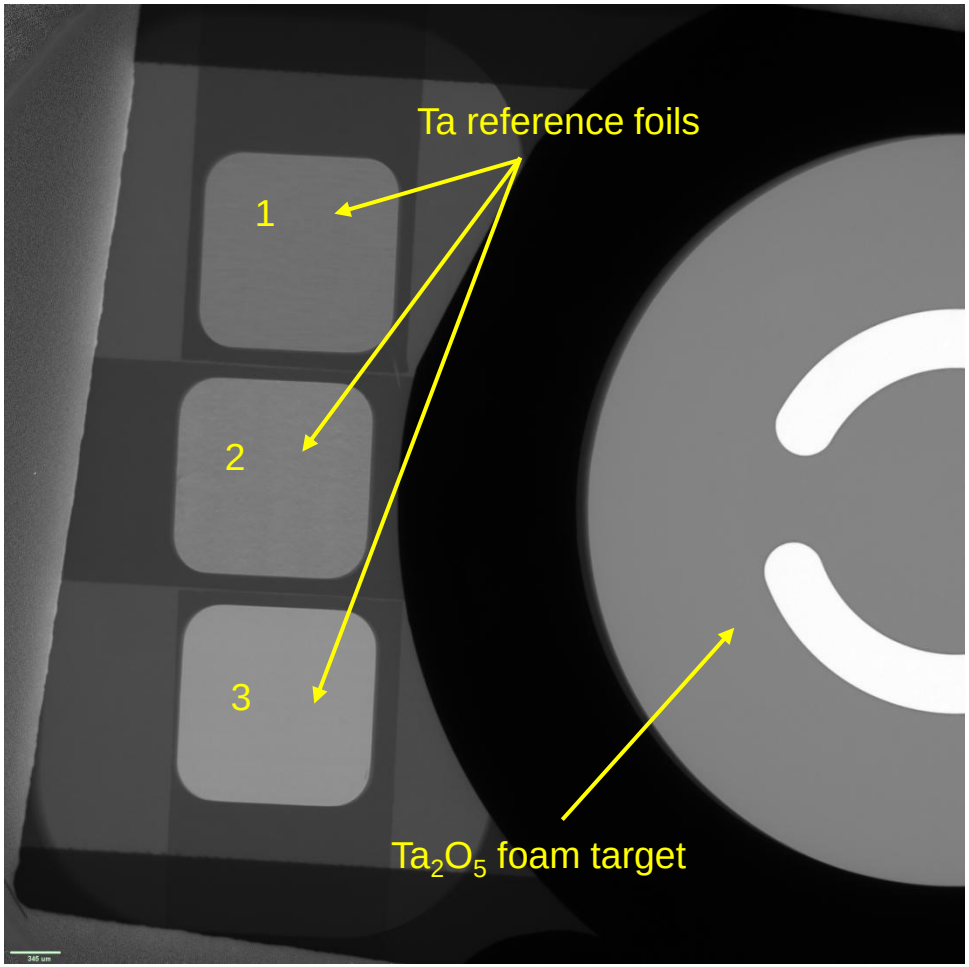
Target type: 2S-2W

Ta reference foil thicknesses

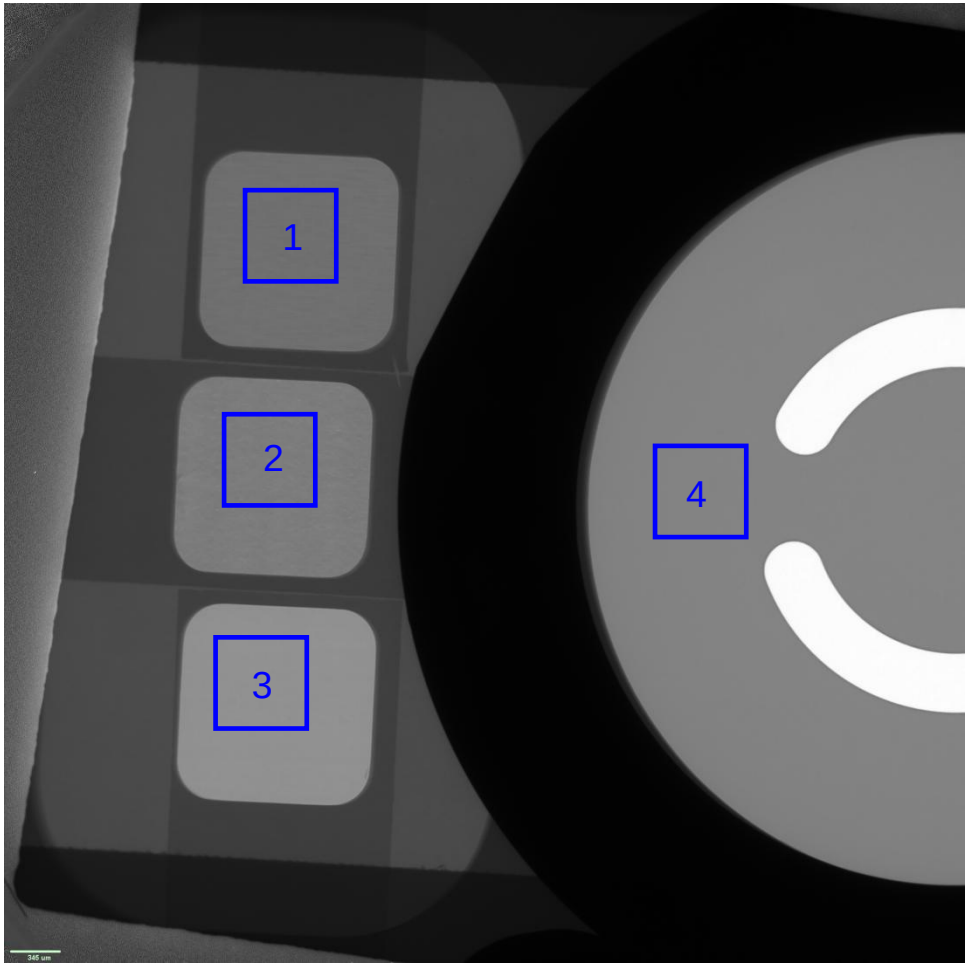
1: 6.6 ± 0.4 µm
2: 5.1 ± 0.4 µm
3: 4.5 ± 0.4 µm

Region of interest





Sample pixel value statistics were calculated for regions within each reference foil and the target.



Sample pixel value means and standard deviations:

1:	43.70 ± 0.51
2:	48.72 ± 0.68
3:	56.67 ± 0.44
4:	51.21 ± 0.37

Note: Each blue square represents a 150-pixel by 150-pixel area.

For known thicknesses of the reference foils and the target, the values above will permit estimation of the density of the target.

The statistics for the reference foils and all of the targets measured to date are being tabulated.

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Target ID	Ref. Foil 1	Ref. Foil 2	Ref. Foil 3	Target
13	42.27 ± 0.27	47.72 ± 0.63	56.13 ± 0.29	51.39 ± 0.22
14	42.13 ± 0.44	47.46 ± 0.65	55.98 ± 0.18	49.97 ± 0.18
15	42.00 ± 0.42	47.38 ± 0.63	55.88 ± 0.26	50.63 ± 0.21
16	42.15 ± 0.44	47.22 ± 0.60	56.01 ± 0.29	51.20 ± 0.20
18	42.13 ± 0.42	47.41 ± 0.62	55.93 ± 0.28	50.75 ± 0.26
19	42.03 ± 0.39	47.41 ± 0.60	55.96 ± 0.31	50.04 ± 0.26
20	42.11 ± 0.42	47.42 ± 0.64	56.06 ± 0.31	51.50 ± 0.26
21	43.56 ± 0.37	48.74 ± 0.54	57.15 ± 0.26	53.10 ± 0.20
23	n/a	n/a	n/a	53.16 ± 0.35
24	n/a	n/a	n/a	52.58 ± 0.44
Mean	**(see next page)**	**(see next page)**	**(see next page)**	**(see next page)**

(Table continued on next page.)

The statistics for the reference foils and all of the targets measured to date are being tabulated.

(Table continued from previous page.)

Target ID	Ref. Foil 1	Ref. Foil 2	Ref. Foil 3	Target
25	44.31 ± 0.48	49.58 ± 0.63	57.76 ± 0.43	54.39 ± 0.39
26	43.89 ± 0.52	48.81 ± 0.68	56.82 ± 0.41	49.69 ± 0.39
27	43.92 ± 0.49	48.96 ± 0.70	57.00 ± 0.41	52.60 ± 0.36
29	43.46 ± 0.41	48.77 ± 0.59	57.08 ± 0.29	54.35 ± 0.20
30	43.30 ± 0.40	48.50 ± 0.59	57.01 ± 0.26	54.03 ± 0.24
31	43.34 ± 0.41	48.68 ± 0.57	57.02 ± 0.26	53.62 ± 0.26
32	43.34 ± 0.42	48.73 ± 0.59	57.05 ± 0.27	53.95 ± 0.23
33	43.30 ± 0.40	48.68 ± 0.59	57.05 ± 0.29	53.99 ± 0.24
35	43.42 ± 0.34	48.69 ± 0.54	57.04 ± 0.25	53.79 ± 0.21
37	44.27 ± 0.51	49.43 ± 0.61	57.75 ± 0.40	53.43 ± 0.37
Mean	**(see next page)**	**(see next page)**	**(see next page)**	**(see next page)**

(Table continued on next page.)

The statistics for the reference foils and all of the targets measured to date are being tabulated.

(Table continued from previous page.)

Target ID	Ref. Foil 1	Ref. Foil 2	Ref. Foil 3	Target
38	43.98 ± 0.50	49.03 ± 0.70	57.15 ± 0.44	52.16 ± 0.36
39	43.86 ± 0.50	48.90 ± 0.69	56.99 ± 0.41	52.49 ± 0.36
41	43.99 ± 0.51	48.93 ± 0.68	56.98 ± 0.42	52.46 ± 0.38
42	43.90 ± 0.50	48.90 ± 0.68	56.92 ± 0.42	52.56 ± 0.36
46	43.76 ± 0.52	48.81 ± 0.69	56.75 ± 0.42	51.97 ± 0.35
49	43.86 ± 0.53	48.88 ± 0.69	56.88 ± 0.45	53.45 ± 0.36
52	43.65 ± 0.50	48.77 ± 0.69	56.74 ± 0.44	52.11 ± 0.36
53	43.84 ± 0.51	48.99 ± 0.72	56.96 ± 0.44	50.38 ± 0.33
54	43.70 ± 0.51	48.72 ± 0.68	56.67 ± 0.44	51.21 ± 0.37
56	44.01 ± 0.52	49.13 ± 0.68	57.32 ± 0.44	54.41 ± 0.38
Mean	**(see next page)**	**(see next page)**	**(see next page)**	**(see next page)**

* Calculated statistics do not include data for T23 and T24.

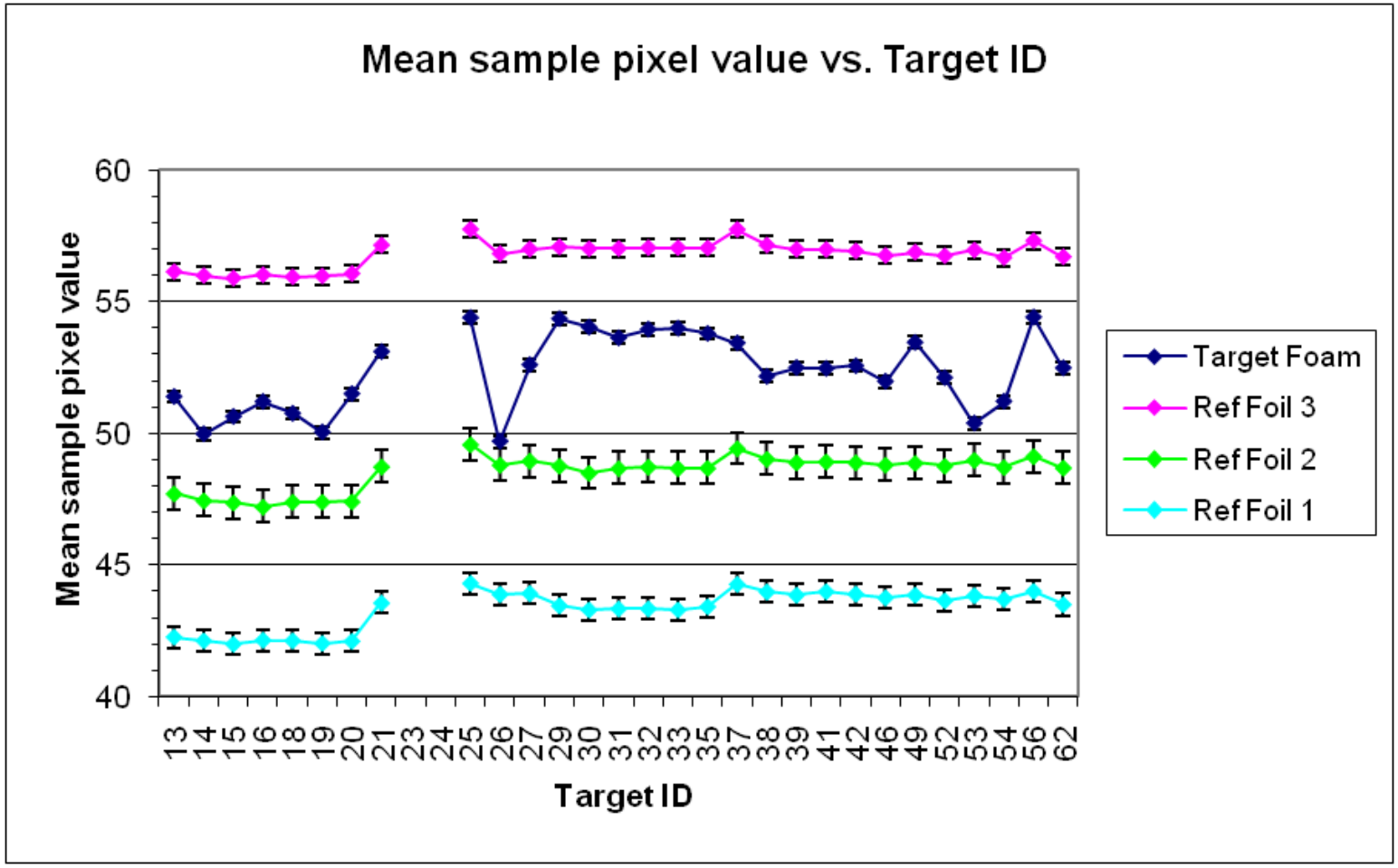
The statistics for the reference foils and all of the targets measured to date are being tabulated.

(Table continued from previous page.)

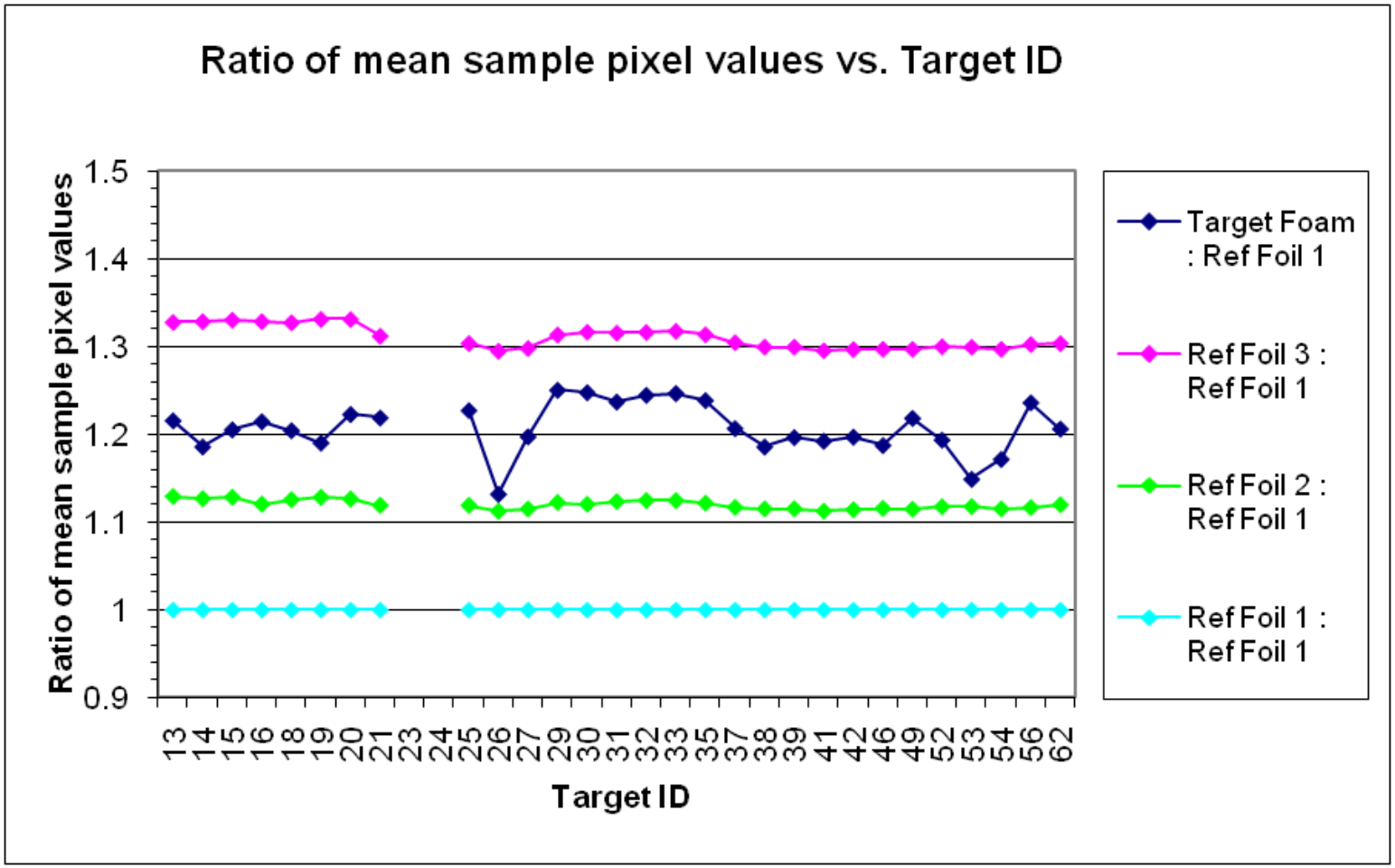
Target ID	Ref. Foil 1	Ref. Foil 2	Ref. Foil 3	Target
62	43.50 ± 0.50	48.70 ± 0.69	56.70 ± 0.44	52.48 ± 0.44
Mean*	**43.34 ± 0.08**	**48.53 ± 0.12**	**56.78 ± 0.07**	**52.35 ± 0.06**

* Calculated statistics do not include data for T23 and T24.

The statistical values for the reference foils and the targets are being plotted both (a) on their own…



... and (b) in the form of a ratio relative to the values for Reference Foil 1.



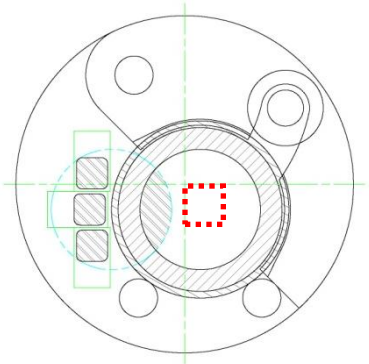
The third data set captured an image of a region of the target with (no) significant features.

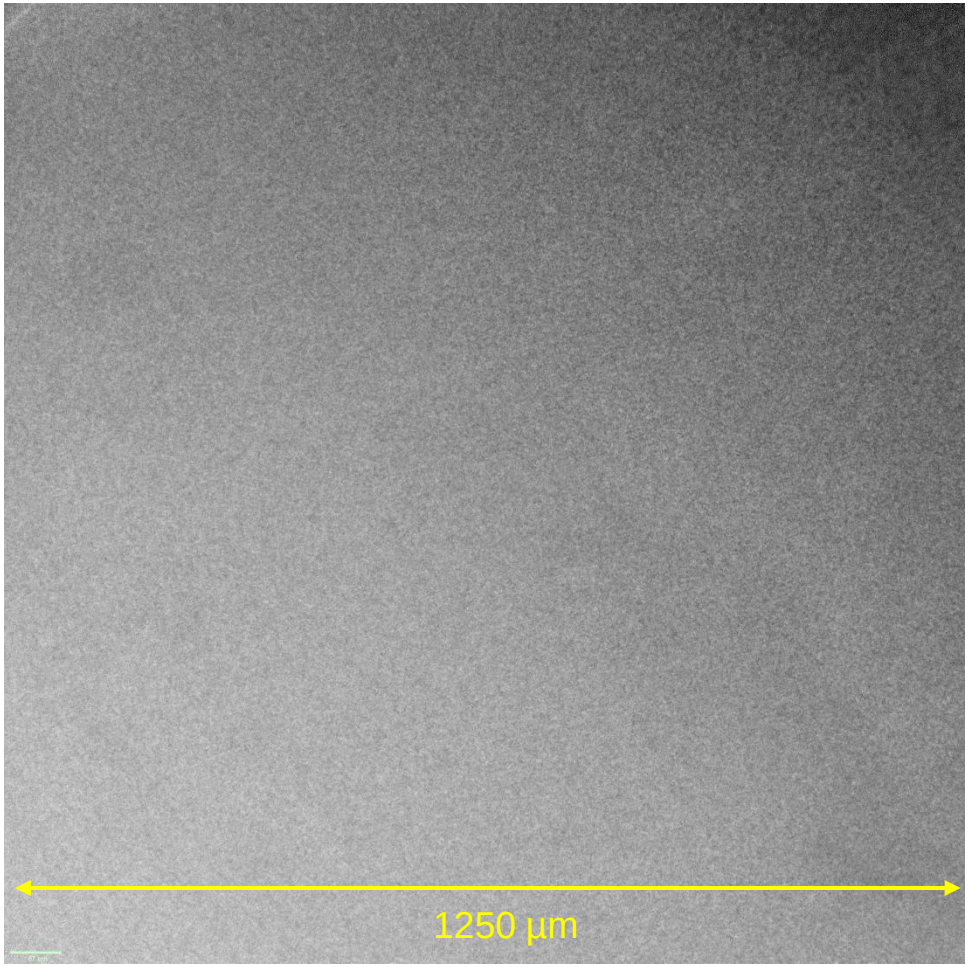
System magnification: 20X

Pixel value dynamic range: restricted

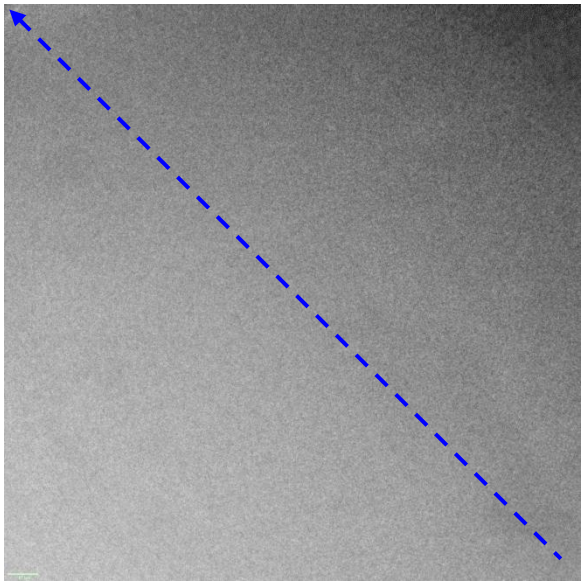
Target type: 2S-2W

Region of interest

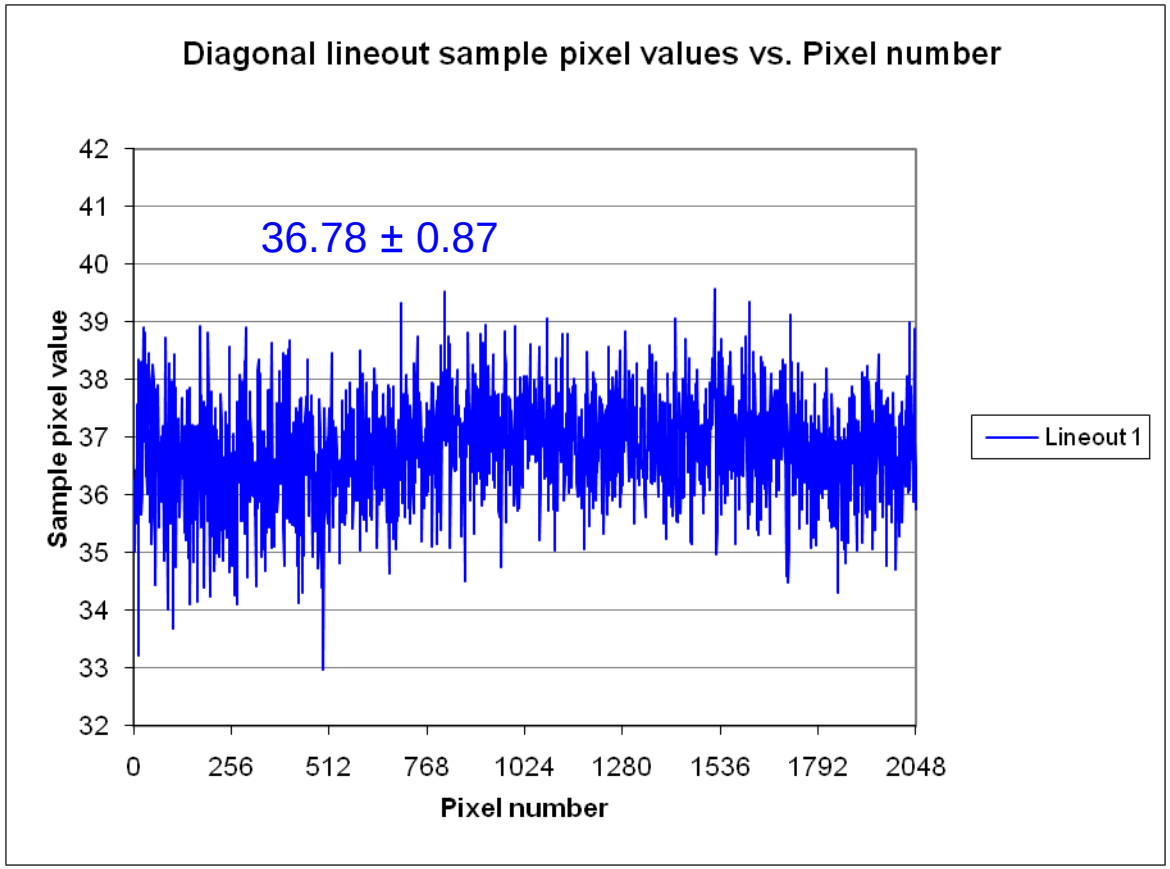




A diagonal lineout shows that the thickness does not deviate significantly from the mean on a local basis.



The sample pixel values have a standard deviation of 2.4% about the sample mean.



Summary

- Digital radiography data was collected for NIF RadHohl 09A Target 54 (MMED #54, NDE #T54).

4X-magnification data set

- The target did meet the defined specification for uniformity in thickness and/or density – namely, that the sample thickness and/or density of the target, within a region bounded by a circle representing 90% of the full radius of the target, shall not deviate more than 4% from the mean sample thickness and/or density.
- No significant non-uniform features were observed.
- The relative attenuation of the target material with respect to three tantalum reference foils of known thickness was measured, tabulated, and plotted in order to facilitate future estimations of the target material density.

20X-magnification data set

- The sample pixel values had – in general and on a local basis (over about 1700 μm in distance) – a standard deviation of about 2.4% with respect to the sample mean.